Technical Document

2007 Utah Hospital Comparison

Adult Heart Surgeries and Conditions:
Charges, Quality and Patient Safety, 2003-2005

A Health Care Consumer's Report for Utahns

Office of Health Care Statistics
Health Data Committee
Utah Department of Health
May 2007

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Introduction

Mandates for Publishing Utah Health Care Consumer's Reports:

Utah Senate Bill 132, titled "Health Care Consumer's Report," passed by the 2005 Utah Legislature, requires the Health Data Committee (HDC) to report annually health facility performance for consumers. The public consumer reports shall use nationally recognized quality and patient safety standards and facility charges for diseases or conditions. In December 2005, the HDC published the consumer maternity and newborn report, the first in a series of hospital comparison reports on hospital charges, quality and patient safety.

Purpose of the Technical Documentation:

This documentation is one of a series of publications that provides technical information and methodological explanations on the Utah Health Care Consumer's Reports. Audience for this publication includes hospital personnel, health professionals, health data analysts and other interested professionals.

The Health Data Committee

The Health Data Committee established the SB 132 Health Care Consumer's Report Task Force in 2005. The SB132 Task Force is a technical advisory group that provides consultation to the Utah Health Data Committee and its staff members in the Office of Health Care Statistics on measures, methods, and priorities for developing Health Care Consumer's Reports and related web reporting system.

The SB132 Health Care Consumer's Report Task Force

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Data Source

The Hospital Discharge Database

The data for the Utah health care consumers' reports come from the statewide hospital discharge database. Administrative Rule R428-10, titled "Health Data Authority, Hospital Inpatient Reporting Rule," mandates that all Utah licensed hospitals, both general acute care and specialty, report information on inpatient discharges. Since 1992, all hospitals have reported "discharge data" for each inpatient served. "Discharge data" mean the consolidation of complete billing, medical, and demographic information describing a patient, the services received, and charges billed for each inpatient hospital stay. Discharge data records are submitted to the office quarterly. The data elements are based on discharges occurring in each calendar quarter.

Method of Reporting Charges

Use of APR-DRG, "All-patient Refined (APR)-Diagnosis Related Group (DRG)"

The APR-DRG, "All-patient Refined (APR)-Diagnosis Related Group (DRG)," classification system is used in the Utah healthcare consumer's reports to categorize discharge records into different diseases/conditions groups of patients.

❑ **Diagnosis Related Group (DRG)**

The DRGs, developed for the Health Care Financing Administration, are a patient classification scheme which relates the type of patients a hospital treats (i.e., its case mix) to the costs incurred by the hospital. While all patients are unique, groups of patients have common demographic, diagnostic and therapeutic attributes that determine their resource needs. All patient classification schemes capitalize on these commonalities and utilize the same principle of grouping patients by common characteristics.

The use of DRGs as the basic unit of payment for Medicare patients represents a recognition of the fundamental role a hospital's "sicker" patients play in determining resource usage and costs, at least on average. "The DRGs, as they are now defined, form a manageable, clinically coherent set of patient classes that relate a hospital's case mix to the resource demands and associated costs experienced by the hospital." (*Diagnosis Related Groups, Seventh Rev., Definitions Manual*, page 15.)

Each discharge in the Utah Health Discharge Database was assigned a DRG based on the principal diagnosis, secondary diagnoses, surgical procedures, age, sex, and discharge status of the patient.

❑ **All-patient Refined (APR)-DRG and Patient Severity Level**

APR-DRG stands for All Patient Refined Diagnosis Related Group, software widely used in health services research. The APR-DRG software organizes about 20,000 clinical diagnoses and procedures into about 300 groups. Each APR-DRG has four severity of illness levels. In the consumer reports, we use "Patient Severity Level" to group patients into one of two groups. The severity of illness and risk of mortality subclasses have levels of 1 to 4, indicating minor, moderate, major, and extreme, respectively. In the consumer reports, patients who are assigned a minor or moderate level of severity of illness are in the Minor/Moderate group, and patients who are assigned a major or extreme level of severity of illness are in the Major/Extreme group. Patients whose care is classified in the Major/Extreme group are those who have multiple conditions, diseases, or illnesses or patients who are much sicker than other patients having the same procedure that are classified in the Minor/Moderate group. This report uses APR-DRG version 20.0 for expected deaths, because AHRQ uses this version for risk adjustment in the Inpatient Quality Indicators. This report also uses APR-DRG version 20.0 for average charges.

Note that other Health Data Committee reports, such as the Utah Inpatient Hospital Utilization and Charges Profile --Hospital Detail report for 2004 and previous years, use APR-DRG Version 15.0.

For details on APR-DRG, see www.3m.com/us/healthcare/his/products/coding/refined_drg.jhtml

Excluding Outlier Cases from Calculating Hospital Average Charges

Some patients have exceptionally low or high lengths of stay or total facility (hospital) charges. A hospital's charges can be affected by just a few unusually long (or short) or expensive (or inexpensive) cases. These high or low values could be a result of coding or data submittal errors, particularly in length of stay, total charges, or data elements that affect APR-DRG assignments. Other reasons for exceptionally low charges could be due to death or transfer to another facility. Exceptionally high charges could be due to a catastrophic condition. Whatever the reason, these values, referred to as "outliers," distort the averages and were excluded from calculations. High charge outliers (facility) are defined in this and subsequent reports as values above 2.5 standard deviations from the state mean for each of the four levels of severity of illness for each APR-DRG. Means and standard deviations are APR-DRG specific and calculated on a statewide basis for a specific calendar year. For this report, the high outlier cases for both charge and length of stay are excluded from calculation of hospital average charges.

Facility Charge is Used for the Consumer's Reports

The Utah Hospital Discharge Database contains two types of charge summary information:
(1) Total Charge - Sum of all charges included in the billing form, including both facility charges and professional fees and patient convenience items. This is different from *cost* of treatment or *payment* received by the hospital.
(2) Facility Charge - Sum of all charges related to using a facility. Facility charge is calculated by subtracting professional fees and patient convenience item charges from total charge.

The facility charge is used for public reporting on hospital charges.

Payment received by the hospital may be less than the total charges billed for the patient's hospital stay due to contractual agreements with the insurance plans and/or charity/hardship programs available.

Average Charge:

This is the calculated average for all the services for which patients in a particular severity of illness group (one of two groups) were billed as the facility charges at a particular hospital for a given condition or procedure. The average was calculated by adding the facility charges for all the services billed at that hospital for a given condition or procedure and then dividing by the total number of patients in this severity of illness group for that condition or procedure.

The method of calculating the average facility charge is identical to the method used in the HDC's standard report: Utah Hospital Utilization and Charge Profile -- Hospital Details, Table ST 1-3. In other words, both publications report average facility charges at APR-DRG and patient severity of illness level (one of four levels) without high outliers.

Average Length of Stay:

The average length of stay was the sum of days all patients stayed in the hospital for a certain condition or procedure divided by the total number of patients who were treated for that condition or procedure. For example, the average length of stay for heart attack patients at Hospital A would be the sum of the days this hospital's heart attack patients stayed divided by the sum of Hospital A's heart attack patients.

The method of calculating the average length of stay is the identical method used in the HDC's standard report: Utah Hospital Utilization and Charge Profile, Hospital Details (ST-1) Table ST 1-3. The average facility length of stay excludes high outliers by APRDRG and patient severity level.

Sources of Quality and Safety Indicators

In compliance with SB 132, the Senate Bill for the Health Care Consumer's Report, the Utah Health Data Committee adopts "nationally recognized standards" for its public reporting on quality and safety. The federal government's agency in charge of health care quality, the Agency of Healthcare Research and Quality (AHRQ) has developed a set of Quality Indicators derived from hospital discharge data. Carolyn M. Clancy, M.D., Director of the federal Agency for Healthcare Research and Quality (AHRQ) has saluted Utah's efforts. She said, "AHRQ views public reporting as one important strategy to advance the quality improvement agenda in health care," Dr. Clancy added, "Evidence shows that publicly reporting performance by specific hospitals is a key element that promotes enhanced patient care." A document entitled "Guidance for Using the AHRQ Quality Indicators for Hospital-level Public Reporting or Payment" is available at: **http://www.qualityindicators.ahrq.gov/documentation.htm**.

Inpatient Quality Indicators (IQIs] and Patient Safety Indicators (PSIs)

These indicators were developed by the Agency for Healthcare Research and Quality (AHRQ) based on inpatient hospital discharge data. Although hospital discharge data do have some limitations, research has shown that IQIs and PSIs may serve as proxies for utilization, quality, or patient outcomes. AHRQ IQI and PSI definitions and analytical methods were used to calculate the utilization and quality/safety indicators in this report. For more detailed information, go to **www.qualityindicators.ahrq.gov/**

This report includes four of the AHRQ IQIs.

Definitions and Codes for Each Indicator in This Report

The following pages are from AHRQ Quality Indicators—Guide to Inpatient Quality Indicators: Quality of Care in Hospitals—Volume, Mortality, and Utilization. Rockville, MD: Agency for Healthcare Research and Quality, 2002, and AHRQ Quality Indicators – Inpatient Quality Indicators Technical Document. Version 3.1 (March 12, 2007)

Percutaneous Transluminal Coronary Angioplasty Mortality Rate (IQI 30)

Percutaneous transluminal coronary angioplasty (PTCA) is a relatively common procedure that requires proficiency with the use of complex equipment, and technical errors may lead to clinically significant complications. The definition for PTCA mortality rate (IQI 30) is also noted below. The QI software calculates mortality for PTCA, so that the volumes for this procedure can be examined in conjunction with mortality. However, the mortality measure should not be examined independently, because it did not meet the literature review and empirical evaluation criteria to stand alone as its own measure.

Relationship to Quality	Better processes of care may reduce short-term mortality, which represents better quality.
Definition	Number of deaths per 100 PTCAs.
Numerator	Number of deaths with a code of PTCA in any procedure field.
Denominator	Discharges with ICD-9-CM codes 0066, 3601, 3602, 3605 in any procedure field. Age 40 years and older. Exclude cases: • missing discharge disposition (DISP=missing) • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • MDC 15 (newborns and other neonates)
Type of Indicator	Provider Level, Mortality Indicator – Recommended for use only with the corresponding volume indicator above.
Empirical Performance	Population Rate (2003): 1.30 per 100 discharges at risk
Empirical Rating	Not available.

Summary of Evidence

PTCA is measured with great precision, although volume indicators overall are not direct measures of quality and are relatively insensitive. For this reason, PTCA should be used in conjunction with measures of mortality and quality of care within cardiac care to ensure that increasing volumes truly improve patient outcomes. As noted in the literature, higher volumes of PTCA have been associated with fewer deaths and post-procedural coronary artery bypass grafts (CABG).

Empirical evidence shows that a moderate to high percentage of procedures were performed at high-volume hospitals. At threshold 1, 95.7% of PTCA procedures were performed at high-volume providers (and 69% of the providers are high volume).[1] At threshold 2, 77.0% were performed at high-volume providers (and 42% of providers are high volume).[2] [3]

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[1] Ryan TJ, Bauman WB, Kennedy JW, et al. Guidelines for percutaneous transluminal coronary angioplasty. .A report of the American Heart Association/American College of Cardiology Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures (Committee on Percutaneous Transluminal Coronary Angioplasty). Circulation 1993;88(6):2987-3007.

[2] Hannan EL, Racz M, Ryan TJ, et al. .Coronary angioplasty volume-outcome relationships for hospitals and cardiologists. JAMA 1997;277(11):892-8.

[3] Nationwide Inpatient Sample and State Inpatient Databases. Healthcare Cost and Utilization Project. Agency for Healthcare Research and Quality, Rockville, MD. Hhttp://www.ahrq.gov/data/hcup

Limitations on Use

As a volume indicator, PTCA is a proxy measure for quality and should be used with other indicators.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

The face validity of PTCA depends on whether a strong association with outcomes of care is both plausible and widely accepted in the professional community. The American Heart Association (AHA) and the American College of Cardiology (ACC) have stated that "a significant number of cases per institution—at least 200 PTCA procedures annually—is essential for the maintenance of quality and safe care."[4] Providers may wish to examine rates by surgeon with this indicator.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

PTCA is an increasingly common procedure (16.7 per 10,000 persons in 1997[5]) and is measured accurately with discharge data. The large number of procedures performed annually at most hospitals suggests that annual volume is not subject to considerable random variation.

Minimal bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Risk adjustment is not appropriate, because volume measures are not subject to bias due to disease severity and comorbidities.

Construct validity: Does the indicator perform well in identifying true (or actual) quality of care problems?

Higher volumes have been repeatedly associated with better outcomes of care, although these findings may be limited by inadequate risk adjustment of the outcome measure.

Using hospital discharge data to adjust for age, gender, multilevel angioplasty, unstable angina, and six comorbidities, one study found that high-volume hospitals had significantly lower rates of same-stay coronary artery bypass surgery (CABG) and inpatient mortality than low-volume hospitals.[6] Better studies based on clinical data systems (adjusting for left ventricular function) have confirmed higher risk-adjusted mortality and CABG rates at low-volume hospitals relative to high-volume hospitals.[7]

Empirical evidence shows that PTCA volume is negatively related to several other post-procedural mortality rates: CABG ($r=-.21$, $p<.001$), craniotomy ($r=-.200$, $p<.0001$), and abdominal aortic aneurysm (AAA) repair ($r=-.45$, $p<.0001$).[8]

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[4] Ryan et al., 1993.

[5] Kozak LJ, Lawrence L. National Hospital Discharge Survey: annual summary, 1997. Vital Health Stat 13 1999(144):i-iv, 1-46.

[6] Ritchie JL, Maynard C, Chapko MK, et al. Association between percutaneous transluminal coronary angioplasty volumes and outcomes in the Healthcare Cost and Utilization Project 1993-1994. Am J Cardiol 1999;83(4):493-7.

[7] Hannan et al. 1997.

[8] Nationwide Inpatient Sample.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Low-volume providers may attempt to increase their volume without improving quality of care by performing the procedure on patients who may not qualify or benefit from the procedure. Additionally, shifting procedures to high-volume providers may impair access to care for certain types of patients.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

PTCA volume has not been widely used as an indicator of quality, although specific volume thresholds have been suggested as "standards" for the profession.[9]

Percutanous Transluminal Coronary Angioplasty Mortality Rate (IQI 30)

Numerator:

Number of deaths (DISP=20).

Denominator:

Discharges with ICD-9-CM codes of 0066, 3601, 3602 or 3605 in any procedure field. Age 40 years and older.

ICD-9-CM PTCA procedure codes:

0066	PERC TRANS CORO ANGIO OCT05-
3601	PTCA-1 VESSEL W/O AGENT
3602	PTCA-1 VESSEL WITH AGNT
3605	PTCA-MULTIPLE VESSEL

Exclude cases:
- missing discharge disposition (DISP=missing)
- transferring to another short-term hospital (DISP=2)
- MDC 14 (pregnancy, childbirth, and puerperium)
- MDC 15 (newborns and other neonates)

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[9] Hirshfeld JW, Jr., Ellis SG, Faxon DP. Recommendations for the assessment and maintenance of proficiency in coronary interventional procedures: Statement of the American College of Cardiology. J Am Coll Cardiol 1998;31(3):722-43.

Coronary Artery Bypass Graft Mortality Rate (IQI 12)

Coronary artery bypass graft (CABG) is a relatively common procedure that requires proficiency with the use of complex equipment; and technical errors may lead to clinically significant complications such as myocardial infarction, stroke, and death.

Relationship to Quality	Better processes of care may reduce mortality for CABG, which represents better quality care.
Benchmark	State, regional, or peer group average.
Definition	Number of deaths per 100 discharges with procedure code of CABG.
Numerator	Number of deaths (DISP=20) with a code of CABG in any procedure field.
Denominator	Discharges with ICD-9-CM codes of 3610 through 3619 in any procedure field. Age 40 years and older. Exclude cases: • missing discharge disposition (DISP=missing) • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • MDC 15 (newborns and other neonates)
Type of Indicator	Provider Level, Mortality Indicator for Inpatient Procedures
Empirical Performance	Population Rate (2003): 3.39 per 100 discharges at risk
Empirical Rating	5

Summary of Evidence

CABG mortality is one of the most widely used and publicized post-procedural mortality indicators. Demographics, comorbidities, and clinical characteristics of severity of disease are important predictors of outcome that may vary systematically by provider. Chart review may help distinguish comorbidities from complications.

This indicator should be considered with length of stay and transfer rates to account for differing discharge practices among hospitals. The use of smoothed estimates to help avoid the erroneous labeling of outlier hospitals is recommended.

Limitations on Use

Some selection of the patient population may lead to bias; providers may perform more CABG procedures on less clinically complex patients with questionable indications. Risk adjustment for clinical factors, or at a minimum APR-DRGs, is recommended because of the confounding bias of this indicator. Finally, the evidence for the construct validity of this indicator is limited.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Post-CABG mortality rates have recently become the focus of State public reporting initiatives.[10]

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[10] Localio AR, Hamory BH, Fisher AC, et al. The public release of hospital and physician mortality data in Pennsylvania. A case study. Med Care 199;35(3):272-286.

Studies suggest that these reports serve as the basis for discussions between physicians and patients about the risks of cardiac surgery.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Without applying hierarchical statistical models to remove random noise, it is likely that hospitals will be identified as outliers as a result of patient variation and other factors beyond the hospital's control. Empirical evidence shows that this indicator is precise, with a raw provider level mean of 5.1% and a standard deviation of 6.2%.[11]

Relative to other indicators, a lower percentage of the variation occurs at the provider level, rather than the discharge level. The signal ratio (i.e., the proportion of the total variation across providers that is truly related to systematic differences in provider performance rather than random variation) is moderate, at 54.5%, indicating that some of the observed differences in provider performance likely do not represent true differences.

Minimal bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Based on studies using large databases, cardiac function, coronary disease severity, and the urgency of surgery appear to be powerful predictors of mortality.[12] Some of these risk factors are not available from administrative data.

Construct validity: Does the indicator perform well in identifying true (or actual) quality of care problems?

Numerous studies have reported an association between hospital volume and mortality after CABG surgery. However, experienced surgeons and surgical teams should be able to improve post-operative mortality by reducing aortic cross-clamp time, which has been repeatedly associated with post-operative mortality after adjusting for a variety of patient characteristics.[13] It is unknown how performance of these processes of care would affect hospital-level mortality rates.

Empirical evidence shows that CABG mortality is positively related to bilateral catheterization and negatively related to laparoscopic cholecystectomy.[14]

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Public reporting of CABG mortality rates may cause providers to avoid high-risk patients. Sixty-three percent of cardiothoracic surgeons surveyed in Pennsylvania reported that they were "less willing" to operate on the most severely ill patients since mortality data were released.[15] However, one study using Medicare data shows no evidence that cardiac surgeons in New York, which also reports

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[11] Nationwide Inpatient Sample and State Databases. Healthcare Cost and Utilization Project. Agency for Healthcare Research and Quality, Rockville, MD. Hhttp://www.ahrq.gov/data/hcup/H

[12] Higgins TL, Estafanous FG, Loop FD, et al. Stratification of morbidity and mortality outcome by preoperative risk factors in coronary artery bypass patients. A clinical severity score. JAMA 1992;267(17):2344-8.

[13] Ottino G, Bergerone S, Di Leo M, et al. Aortocoronary bypass results: a discriminant multivariate analysis of risk factors of operative mortality. J Cardiovasc Surg (Torino) 1990;31(1):20-5.

[14] Nationwide Inpatient Sample.

[15] Hannan EL, Siu AL, Kumar D, et al. Assessment of coronary artery bypass graft surgery performance in New York. Is there a bias against taking high-risk patients? Med Care 1997;35(1):49-56.

CABG mortality rates, avoided high-risk patients.[16] All in-hospital mortality measures may encourage earlier post-operative discharge, shifting deaths to skilled nursing facilities or outpatient settings and causing biased comparisons across hospitals with different mean lengths of stay.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

CABG mortality is publicly reported by California, New Jersey, New York, and Pennsylvania. Recent users of CABG mortality as a quality indicator include the University Hospital Consortium, the Joint Commission on Accreditation of Healthcare Organizations' (JCAHO's) IMSystem, Greater New York Hospital Association, the Maryland Hospital Association (as part of the Maryland QI Project) and HealthGrades.com.

Coronary Artery Bypass Graft (CABG) Mortality Rate (IQI 12)

Numerator:
    Number of deaths (DISP=20) with a code of CABG in any procedure field.

Denominator:
Discharges with ICD-9-CM codes of 3610 through 3619 in any procedure field.

Age 40 years and older.

ICD-9-CM CABG procedure codes:

3610	AORTOCORONARY BYPASS NOS	3615	1 INT MAM-COR ART BYPASS
3611	AORTOCOR BYPAS-1 COR ART	3616	2 INT MAM-COR ART BYPASS
3612	AORTOCOR BYPAS-2 COR ART	3617	ABD-CORON ART BYPASS OCT96-
3613	AORTOCOR BYPAS-3 COR ART	3619	HRT REVAS BYPS ANAS NEC
3614	AORTCOR BYPAS-4+ COR ART		

Exclude cases:
- missing discharge disposition (DISP=missing)
- transferring to another short-term hospital (DISP=2)
- MDC 14 (pregnancy, childbirth, and puerperium)
- MDC 15 (newborns and other neonates)

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[16] Peterson ED, DeLong ER, Jollis JG, et al. Public reporting of surgical mortality: a survey of new York State cardiothoracic surgeons. Ann Thorac surg 1999;68(4):1195-200; discussion 12-1-2.

Acute Myocardial Infarction Mortality Rate, Without Transfer Cases (IQI 32)

Timely and effective treatments for acute myocardial infarction (AMI), which are essential for patient survival, include appropriate use of thrombolytic therapy and revascularization.

Relationship to Quality	Better processes of care may reduce mortality for AMI, which represents better quality.
Benchmark	State, regional, or peer group average.
Definition	Number of deaths per 100 discharges with a principal diagnosis code of AMI.
Numerator	Number of deaths (DISP=20) with a principal diagnosis code of AMI.
Denominator	All discharges with a principal diagnosis code of AMI. Age 18 years and older. Exclude cases: • missing discharge disposition (DISP=missing) • transferring to another short-term hospital (DISP=2) • missing admission source (ASOURCE=missing) • transferring from another short-term hospital (ASOURCE=2)
Type of Indicator	Provider Level, Mortality Indicator for Inpatient Conditions
Empirical Performance	Population Rate (2003): 9.75 per 100 discharges at risk
Empirical Rating	Not available

Summary of Evidence

Reductions in the mortality rate for AMI on both the patient level and the provider level have been related to better processes of care. AMI mortality rate is measured with adequate precision, although some of the observed variance may not actually reflect true differences in performance. Risk adjustment may be important—particularly for the extremes. Otherwise, some providers may be mislabeled as outliers.

Two methods of calculating AMI mortality are included in the AHRQ QIs. The second method (IQI 32) was added in Revision 3, and reflected the desire of users to have an alternative method of measuring AMI mortality that excluded patients transferred from another hospital. IQI 32 excludes incoming transfers, however, doing so results in the loss of transferred AMI patients from any quality measurement (since outgoing transfers are already excluded). Therefore, some users may wish to use the AMI Mortality Rate to ensure the inclusion of all AMI patients.

Limitations on Use

Thirty-day mortality may be significantly different than in-hospital mortality, leading to information bias. This indicator should be considered in conjunction with length-of-stay and transfer rates. Risk adjustment for clinical factors (or, at a minimum, APR-DRGs) is recommended.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

AMI affects 1.5 million people each year, and approximately one-third die in the acute phase of the heart attack.[17] Studies that show processes of care linked to survival improvements have resulted in detailed practice guidelines covering all phases of AMI management.[18]

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

The precision of AMI mortality rate estimates may be problematic for medium and small hospitals. Empirical evidence shows that this indicator is precise, with a raw provider level mean of 24.4% and a standard deviation of 16.1%.[19]

Relative to other indicators, a higher percentage of the variation occurs at the provider level rather than the discharge level. The signal ratio (i.e., the proportion of the total variation across providers that is truly related to systematic differences in provider performance rather than random variation) is moderate, at 42.8%, indicating that some of the observed differences in provider performance likely do not represent true differences.

Minimal bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Numerous studies have established the importance of risk adjustment for AMI patients. The most important predictors of short-term AMI mortality have been shown to include age, previous AMI, tachycardia, pulmonary edema and other signs of congestive heart failure, hypotension and cardiogenic shock, anterior wall and Q-wave infarction, cardiac arrest, and serum creatinine or urea nitrogen.

Using different risk adjustment methods or data sources (administrative versus clinical data) affects which specific hospitals are identified as outliers.[20] [21]

Construct validity: Does the indicator perform well in identifying true (or actual) quality of care problems?

When Meehan et al. evaluated coding accuracy, severity of illness, and process-based quality of care in Connecticut hospitals, they found that the hospitals with the highest risk-adjusted mortality had significantly lower utilization of beneficial therapies.[22]

In the California Hospital Outcomes Project, hospitals with low risk-adjusted AMI mortality were more likely to give aspirin within 6 hours of arrival in the emergency room, perform cardiac catheterization and

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[17] American Heart Association. Heart Attack and Stroke Facts: 1996 Statistical Supplement. Dallas, TX: American Heart Association; 1996.

[18] Ryan TJ, Antman EM, Brooks NH, et al. 1999 update: ACC/AHA guidelines for the management of patients with acute myocardial infarction. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Management of Acute Myocardial Infarction). J Am Coll Cardiol 1999;34(3):890-911.

[19] Nationwide Inpatient Sample and State Inpatient Databases. . Healthcare Cost and Utilization Project. Agency for Healthcare Research and Quality, Rockville, MD. Hhttp://www.ahrq.gov/data/hcupH

[20] Landon B, Iezzoni LI, Ash AS, et al. Judging hospitals by severity-adjusted mortality rates: the case of CABG surgery. Inquiry 1996;33(2):155-66.

[21]Second Report of the California Hospitals Outcomes Project, May 1996, Acute Myocardial Infarction. Sacramento, CA: Office of Statewide Health Planning and Development; 1996.

[22] Meehan TP, Hennen J, Radford MJ, et al. Process and outcome of care for acute myocardial infarction among Medicare beneficiaries in Connecticut: a quality improvement demonstration project. Ann Intern Med 1995;122(12):928-36.

revascularization procedures within 24 hours, and give heparin to prevent thromboembolic complications.[23]

Empirical evidence shows that AMI mortality is correlated with bilateral catheterization (r=-.16, p<.0001), mortality for congestive heart failure (CHF) (r=.46, p<.0001), pneumonia (r=.46, p<.0001), coronary artery bypass graft (CABG) (r=.50, p<.0001), stroke (r=.40, p<.0001), and gastrointestinal hemorrhage (r=.38, p<.0001).[24]

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

The use of AMI mortality as an indicator is unlikely to impede access to needed care. However, a few patients who fail to respond to resuscitative efforts may not be admitted if there is pressure to reduce inpatient mortality.

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

AMI mortality has been widely used as a hospital quality indicator by State health departments and the Joint Commission for the Accreditation of Healthcare Organizations (JCAHO).

AMI mortality measured by IQI 32 is closely related to the JCAHO indicator for AMI mortality. Unlike the existing indicator for AMI mortality (IQI #15), it excludes patients transferring from another short-term hospital and patients missing admission source. This indicator is NOT risk adjusted in the same manner as the JCAHO indicator and does not exclude hospice patients as the JCAHO indicator (due to inability to identify hospice patients in data).

Acute Myocardial Infarction (AMI) Mortality Rate, Without Transfer Cases (IQI 32)
Numerator: Number of deaths (DISP=20) with a principal diagnosis code of AMI.

Denominator:
    All discharges with a principal diagnosis code of AMI.
    Age 18 years and older.
 	
ICD-9-CM AMI diagnosis codes:

41001	AMI ANTEROLATERAL, INIT	41051	AMI LATERAL NEC, INITIAL
41011	AMI ANTERIOR WALL, INIT	41061	TRUE POST INFARCT, INIT
41021	AMI INFEROLATERAL, INIT	41071	SUBENDO INFARCT, INITIAL
41031	AMI INFEROPOST, INITIAL	41081	AMI NEC, INITIAL
41041	AMI INFERIOR WALL, INIT	41091	AMI NOS, INITIAL

Exclude cases:
- missing discharge disposition (DISP=missing)
- transferring to another short-term hospital (DISP=2)
- missing admission source (ASOURCE=missing)
- transferring from another short-term hospital (ASOURCE=2)

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[23] Second Report of the California Hospitals Outcomes Project, May 1996. Acute Myocardial Infarction. Sacramento, CA: Office of Statewide Health Planning and Development; 1996.

[24] Nationwide Inpatient Sample.

Congestive Heart Failure Mortality Rate (IQI 16)

Congestive heart failure (CHF) is a progressive, chronic disease with substantial short-term mortality, which varies from provider to provider.

Relationship to Quality	Better processes of care may reduce short-term mortality, which represents better quality.
Benchmark	State, regional, or peer group average.
Definition	Number of deaths per 100 discharges with principal diagnosis code of CHF.
Numerator	Number of deaths (DISP=20) with a principal diagnosis code of CHF.
Denominator	All discharges with a principal diagnosis code of CHF. Age 18 years and older. Exclude cases • missing discharge disposition (DISP=missing) • transferring to another short-term hospital (DISP=2) • MDC 14 (pregnancy, childbirth, and puerperium) • MDC 15 (newborns and other neonates).
Type of Indicator	Provider Level, Mortality Indicator for Inpatient Conditions
Empirical Performance	Population Rate (2003): 4.33 per 100 discharges at risk
Empirical Rating	6

Summary of Evidence

CHF is a relatively common admission, with a relatively high short-term mortality rate. Certain procedures have been shown to decrease short-term CHF mortality on a patient level, but the impact of these practices on decreasing provider-level mortality is unknown.

CHF mortality has not been studied extensively as an indicator; however, some risk models have been developed that demonstrate the importance of comorbidities and some clinical factors in predicting death. Risk adjustment may be important—particularly for the extremes. Otherwise, some providers may be mislabeled as outliers.

Limitations on Use

CHF care occurs in an outpatient setting, and selection bias may be a problem for this indicator. In addition, 30-day mortality may be significantly different than in-hospital mortality, leading to information bias. Risk adjustment for clinical factors (or at a minimum APR-DRGs) is recommended.

Details

Face validity: Does the indicator capture an aspect of quality that is widely regarded as important and subject to provider or public health system control?

Approximately 2 million persons in the United States have heart failure each year.[25] These numbers will heart failure patients. In a study of 29,500 elderly patients in Oregon, the 3-day mortality decreased by

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[25] Smith, WM. Epidemiology of congestive heart failure. Am J Cardiol 1985;55(2):3A-8A.

likely increase as the population ages. The literature suggests that hospitals have improved care for 41% from 1991 to 1995.[26]

The accuracy of ICD-9-CM coding for heart failure has been questioned. Although the specificity of a principal diagnosis of heart failure is high, the sensitivity is low.[27] Face validity will be maximized by limiting analyses to patients with a principal diagnosis of heart failure.

Precision: Is there a substantial amount of provider or community level variation that is not attributable to random variation?

Empirical evidence shows that this indicator is precise, with a raw provider level mean of 7.5% and an standard deviation of 9.5%.[28]

Relative to other indicators, a lower percentage of the variation occurs at the provider level rather than the discharge level. The signal ratio (i.e., the proportion of the total variation across providers that is truly related to systematic differences in provider performance rather than random variation) is moderate, at 53.5%, indicating that some of the observed differences in provider performance likely do not represent true differences.

Minimal bias: Is there either little effect on the indicator of variations in patient disease severity and comorbidities, or is it possible to apply risk adjustment and statistical methods to remove most or all bias?

Mortality is greatly influenced by age, transfer, cerebrovascular disease, chronic obstructive pulmonary disease, hyponatremia, other hydro-electrolytic disturbance, metastatic disease, renal disease, ventricular arrhythmia, liver disease, malignancy, hypotension, and shock.[29][30][31]

Construct validity: Does the indicator perform well in identifying true (or actual) quality of care problems?

No studies specifically examined the construct validity of in-hospital mortality from heart failure. Although processes of care have been shown to decrease mortality on a patient level, the effect of these processes of care on provider-level mortality rates is unknown.

Empirical evidence shows that CHF mortality is positively related to other mortality indicators, such as pneumonia, gastrointestinal hemorrhage, and stroke.

Fosters true quality improvement: Is the indicator insulated from perverse incentives for providers to improve their reported performance by avoiding difficult or complex cases, or by other responses that do not improve quality of care?

Risk-adjusted measures of mortality may lead to an increase in coding of comorbidities. All in-hospital

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[26] Ni H, Hershberger FE. Was the decreasing trend in hospital mortality from heart failure attributable to improved hospital care? The Oregon experience, 1991-1995. Am J Manag Care 1999;5(9):1105-15.

[27] Goff, DC, Jr., Pandey DK, Chan FA, et al. Congestive heart failure in the United States: is there more than meets the I(CD code)? The Corpus Christi Heart Project. Arch Intern Med 2000;160(2):197-202.

[28] Nationwide Inpatient Sample and State Inpatient Databases. Healthcare Cost and Utilization Project. Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/data/hcup

[29] Yusuf, et al. 1989.

[30] MacIntyre K, Capewell lS, Stewart S, et al. Evidence of improving prognosis in heart failure: trends in case fatality in 66,547 patients hospitalized between 1986 and 1995 [see comments]. Circulation 2000;102(10):1126-31.

[31] Psaty BM, Boineau R, Kuller LH, et al. The potential costs of upcoding for heart failure in the United States. Am J Cardiol 1999;84(1):108-9, A9.

mortality measures may encourage earlier post-operative discharge, and thereby shift deaths to skilled nursing facilities or outpatient settings. However, Rosenthal et al. found no evidence that hospitals with lower in-hospital standardized mortality had higher (or lower) early post-discharge mortality.[32]

Prior use: Has the measure been used effectively in practice? Does it have potential for working well with other indicators?

CHF mortality has been widely used as a quality indicator. HealthGrades.com, the University Hospital Consortium, and the Greater New York Hospital Association have used this measure. The Maryland Hospital Association includes this measure in its Maryland QI Project Indicator set. Likewise, the Michigan Hospital Association includes CHF in an aggregated mortality measure.

Congestive Heart Failure (CHF) Mortality Rate (IQI 16)

Numerator:
　　Number of deaths (DISP=20) with a principal diagnosis code of CHF.

Denominator:
　　All discharges with principal diagnosis code of CHF.
　　Age 18 years and older.

ICD-9-CM CHF diagnosis codes:

39891	RHEUMATIC HEART FAILURE	42821	AC SYSTOLIC HRT FAILURE OCT02-
40201	MAL HYPERT HRT DIS W CHF	42822	CHR SYSTOLIC HRT FAILURE OCT02-
40211	BENIGN HYP HRT DIS W CHF	42823	AC ON CHR SYST HRT FAIL OCT02-
40291	HYPERTEN HEART DIS W CHF	4289	HEART FAILURE NOS
40401	MAL HYPER HRT/REN W CHF	42830	DIASTOLIC HRT FAILURE NOS OCT02-
40403	MAL HYP HRT/REN W CHF&RF	42831	AC DIASTOLIC HRT FAILURE OCT02-
40411	BEN HYPER HRT/REN W CHF	42832	CHR DIASTOLIC HRT FAIL OCT02-
40413	BEN HYP HRT/REN W CHF&RF	42833	AC ON CHR DIAST HRT FAIL OCT02-
40491	HYPER HRT/REN NOS W CHF	42840	SYST/DIAST HRT FAIL NOS OCT02-
40493	HYP HT/REN NOS W CHF&RF	42841	AC SYST/DIASTOL HRT FAIL OCT02-
4280	CONGESTIVE HEART FAILURE	42842	CHR SYST/DIASTL HRT FAIL OCT02-
4281	LEFT HEART FAILURE	42843	AC/CHR SYST/DIA HRT FAIL OCT02-
42820	SYSTOLIC HEART FAILURE NOS OCT02-		

Exclude cases:
　　　• missing discharge disposition (DISP=missing)
　　　• transferring to another short-term hospital (DISP=2)
　　　• MDC 14 (pregnancy, childbirth, and puerperium)
　　　• MDC 15 (newborns and other neonates)

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[32] Rosenthal GE, Baker DW, Norris DG, et al. Relationships between in-hospital and 30-day standardized hospital mortality: implications for profiling hospitals. Health Serv Res 2000;34(7):1449-68.

Agency for Healthcare Research and Quality (AHRQ) Rates

The AHRQ Quality Indicators Software outputs several rates. The AHRQ Quality Indicators e-Newsletter, June 2005, provided guidance to users for appropriate rates to use for specific purposes.

QI Tips: Using Different Types of QI Rates

Which rate should you use, the observed (actual), expected, risk adjusted, and/or smoothed rates?

Here are some guidelines.

If the user's primary interest is to identify cases for the health care provider's internal follow-up and quality improvement, then the **observed rate** would help to identify them. *The observed rate is the raw rate generated by the QI software from the data the user provided.* Areas for improvement can be identified by the magnitude of the observed rate compared to available benchmarks and/or by the number of patients impacted.

Additional breakdowns by the default patient characteristics used in stratified rates (e.g., age, gender, or payer) can further identify the target population. Target populations can also be identified by user-defined patient characteristics supplemented to the case/discharge level flags. Trend data can be used to measure change in the rate over time.

Another approach to identify areas to focus on is to compare the observed and **expected rates**. *The expected rate is the rate the provider would have if it performed the same as the reference population given the provider's actual case-mix (e.g., age, gender, APR-DRG and comorbidity categories)*. This case mix is not the same as the Case Mix Index calculated and reported in the Office Health Care Statistics Standard Reports.

If the observed death rate is higher than the expected rate (i.e., the ratio of observed/expected is greater than 1.0, or observed minus expected is positive), then the implication is that the provider had more deaths than the reference population for that particular indicator. Users may want to focus on these indicators for quality improvement.

If the observed death rate is lower than the expected rate (i.e., the ratio of observed/expected is less than 1.0, or observed minus expected is negative), then the implication is that the provider had fewer deaths than the reference population. Users may want to focus on these indicators for identifying best practices.

If the observed use rate is higher than the expected rate, then the implication is that the provider had more patients with the specified procedure than the reference population for that particular indicator. If the observed use rate is lower than the expected rate, then the implication is that the provider had fewer patients with the specified procedure than the reference population for that particular indicator.

Users can also compare the expected rate to the **population rate** reported in the detailed evidence section of the IQI, PQI, or PSI Guide to determine how their case-mix compares to the reference population. If the population rate is higher than the expected rate, then the provider's case-mix is less severe than the reference population. If the population rate is lower than the expected rate, then the provider's case-mix is more severe than the reference population.

AHRQ uses this difference between the population rate and the expected rate to "adjust" the observed rate to account for the difference between the case-mix of the reference population and the provider's case-mix. This is the provider's **risk-adjusted rate**.

If the provider has a less severe case-mix, then the adjustment is positive (population rate > expected rate) and the risk-adjusted rate is higher than the observed rate. If the provider has a more severe case-mix, then the adjustment is negative (population rate < expected rate) and the risk-adjusted rate is lower than

the observed rate. *The risk-adjusted rate is the rate the provider would have if it had the same case-mix as the reference population given the provider's actual performance.* This case mix is not the same as the Case Mix Index calculated and reported in the Office Health Care Statistics Standard Reports.

Finally, users can compare the risk-adjusted rate to the **smoothed** or "reliability-adjusted" rate to determine whether this difference between the risk-adjusted rate and reference population rate is likely to remain in the next measurement period. *Smoothed rates are weighted averages of the population rate and the risk-adjusted rate, where the weight reflects the reliability of the provider's risk-adjusted rate.*

A ratio of (smoothed rate - population rate) / (risk-adjusted rate - population rate) greater than 0.80 suggests that the difference is likely to persist (whether the difference is positive or negative). A ratio of less than 0.80 suggests that the difference may be due in part to random differences in patient characteristics (patient characteristics that are not observed and controlled for in the risk-adjustment model). In general, users may want to focus on areas where the differences are more likely to persist.

From http://qualityindicators.ahrq.gov/newsletter/2005-June-AHRQ-QI-Newsletter.htm#Headline3 (Accessed on January 18, 2006).

Statistical Tests and Rating System

Star Rating

The star rating system in the report is based on a test of statistical significance. This test shows whether the difference between a hospital's observed (actual) rate and the expected rate is real or just due to chance. For each indicator, the upper and lower 95% confidence intervals were calculated for each hospital's rate. The 95% confidence interval is the interval that one can be 95% certain contains the "true" hospital average. The 95% confidence interval for each hospital was then compared to the expected rate. If the lower limit of 95% confidence interval of a hospital rate is higher than the expected rate, that means the hospital rate is significantly higher than the expected rate. It is rated as one star, " * ". If the higher limit of 95% confidence interval of a hospital rate is lower than the expected rate that means the hospital rate is significantly lower than the expected rate. It is rated as three stars, " *** ". If a hospital's 95% confidence intervals overlap with the expected rate, the hospital rate is not significantly different from the expected rate, and is rated as two stars, " ** ". For selected death rate indicators, if a hospital had no deaths and had at least 30 discharges in the denominator for three years, the hospital received three stars.

Keep in mind that many factors affect the hospital's rates. For example, in this health care consumer report series a hospital that cares for a lot of high-risk patients may have a higher rate of a quality or safety indicator, but that does not mean that the hospital delivers poor quality care.

95% Confidence Interval

Most methods for calculation of confidence intervals assume a normal distribution among the values for which the confidence intervals are calculated. However, these formulas do not work well on small numbers. The formula for exact confidence intervals does not assume a normal distribution. Instead, confidence intervals of the actual (observed) rate are calculated using the method of exact confidence intervals for the cumulative binomial distribution (Holubkov, 1998). This method is more appropriate for rates based on small numbers than other methods and is used in this report's rating system.

The statistical formulas to calculate standard errors and 95% confidence intervals are as follows:

[[Pi].sub.L]=x/(x+[n-x+1][F.sub..025,2n-2x+2,2x])
[[Pi].sub.U]=(x+1)/(x+1+[n-x][[[F.sub..025,2x+2,2n-2x]].sup.-1])

Formulas used in the Excel worksheet to calculate the values for indicators based on number of patients per 100 are:

95% CI LowerLimit = (x/(x+(n-x+1)*finv(0.025, (2*(n-x)+2), 2*x))*100
95% CI UpperLimit = ((x+1)/(x+1+(n-x)/finv(0.025, 2*x+2, 2*(n-x))))*100

      Where:
      [Pi].sub.L = Value of 95% Confidence Interval Lower Limit
      [Pi].sub.U = Value of 95% Confidence Interval Lower Limit
      x   = numerator/number of events
      n   = denominator/number of risk population
      F   = F distribution
      F.sub..025 = Selected critical value for 95% Confidence Interval

For indicators based on number of patients per 1,000, the formulas are the same except that the last term is 1,000 instead of 100.

The health care consumer reports use the values that these formulas produce. An exception is cases in which the lower limit is a negative value. These negative values are converted to zero.

Reference: Holubkov, R. 1998 (August). "Analysis, assessment, and presentation of risk-adjusted statewide obstetrical care data: the StORQS II study in Washington State-Statewide Obstetrics Review and Quality System" published in Health Service Research.

Health care consumer reports may use some of the following additional methods:

I. AHRQ Method for Calculating Standard Errors for the Actual (Observed) Rates

      1) The root mean squared error (RMSE) for each QI for "Hospital J" is:

          RMSE = sqrt(RATEij*(1-RATEij))

          where RATEij is the observed rate for "QI #i" and "Hospital J"

      2) The standard error on the observed rate for "Hospital J" is:

          SE=RMSE/ SQRT (Nij)

          where Nij is the denominator for "QI #i" and "Hospital J"

      4) The 95% confidence interval on the observed rate for "Hospital J" for each QI is:

Lower confidence interval = "Hospital J" observed rate – (1.96 * SE)
Upper confidence interval = "Hospital J" observed rate + (1.96 * SE)

5) For example, if the rate for "Hospital J" for IQI #12 is Rate=0.10 and the denominator is N=20,000, then the lower bound 95% CI is:

0.10 - 1.96 * sqrt[(0.10 * (1-0.10)) / 20000] =
0.10 - 1.96 * 0.021213 =
0.10 - 0.041578

and the upper bound 95% CI is:

0.10 + 1.96 * sqrt[(0.10 * (1-0.10)) / 20000] =
0.10 + 1.96 * 0.021213 =
0.10 + 0. 041578

II. Calculating Standard Errors for the IQI Risk-adjusted Rates

Risk adjusted rates

1) Open the file IQI_V21_R4_RMSE.xls in the AHRQ Quality Indicator Software Package

2) The column labeled "RMSE" is the root mean squared error (RMSE) for each IQI based on the risk-adjustment model.

3) The standard error on the risk-adjusted rate for "Hospital J" is:

SE=SQRT(MSE/Nij) = RMSE/ SQRT (Nij)

where Nij is the denominator for "IQI #i" and "Hospital J"

4) The 95% confidence interval on the risk-adjusted rate for "Hospital J" for each IQI is:

Lower confidence interval = "Hospital J" risk-adjusted rate – (1.96 * SE)
Upper confidence interval = "Hospital J" risk-adjusted rate + (1.96 * SE)

5) For example, if the denominator for "Hospital J" for IQI #12 is N=20,000, then RMSE= 0.171757 and the lower bound 95% CI is:

rate - 1.96 * (0. 171757 / sqrt(20000)) =
rate - 1.96 * 0.012145 =
rate - 0.023804

and the upper bound 95% CI is:

rate + 1.96 * (0. 171757 / sqrt(20000)) =
rate + 1.96 * 0.012145 =
rate + 0.023804

Limitations

Many factors affect a hospital's performance on quality and safety measures as well as charges. Such factors include the hospital's size, the number of cases with a specified condition or procedure, available specialists, teaching status and especially how ill the hospital's patients are. Hospitals that treat high-risk (very ill) patients may have higher percentages of deaths and higher charges than hospitals that transfer these patients. Hospitals that treat patients with do not resuscitate (DNR) orders or other terminally ill patients receiving palliative care (comfort care) may have higher percentages of deaths. Hospitals may report patient diagnosis codes differently which could impact the comparison of quality measurement among hospitals. The quality indicators adjust for how ill each hospital's patients are, but the adjustment may not capture the full complexity of the patient's condition. The Utah Hospital Discharge Database includes up to nine diagnoses and up to six procedures for each patient. Some patients have additional diagnoses and procedures that are not included in this database. As a result, the measures of patient illness may not be complete. See Glossary for more about specific indicators.

The average charge shown in this report differs from "costs," "reimbursement," "price" and "payment." Many factors will affect the cost for your hospital stay, including whether you have health insurance, the type of insurance and the billing procedures at the hospital. This report excludes outlier (unusually high) charge cases and length of stay cases from the calculation of average charge (see Glossary).

This report shows total billed facility charges. Billed charges are to be used as only one indicator of hospital performance. All patients, or insurance plans, do not pay the same amount for similar treatments, supplies, services, and procedures, even though they may be billed the same amount. Different payers have varied arrangements with each hospital for payment. Hospitals offer a variety of contracts, many with discount arrangements based on volume. Because of this, the data reflects pre-contractual prices for hospitalization and not the actual payment between providers and payers. Each patient may have additional charges from physicians, such as the surgeon and the anesthesiologist.

This report can be used to compare broad measures of utilization for all hospitals, but more detailed data are needed to look at specific performance comparisons between hospitals. This information serves as an important first step toward consumers' taking a more active role in health care decision-making.

The price of hospital services, while important, is not the only consideration in making inpatient hospital decisions. Other factors that may influence hospital services, including: the type of condition treated, the physicians who practice at the hospital, and the insurance company's managed care policies. The health plan subscriber should be familiar with his or her health plan long before hospital care is needed. For additional information on managed care performance, please contact the Office of Health Care Statistics at (801) 538-7048.

Appendix A

The expected rate comes from a logistic regression that AHRQ analysts have run on all the inpatients in the National Inpatient Database 2004. The logistic regression produces coefficients (or weights) for each variable for each AHRQ Inpatient Quality Indicator (IQI) and Patient Safety Indicator (PSI). The variables vary by Indicator. Each Indicator has selection criteria for which patients to include. The AHRQ software assigns coefficients for each included inpatient, depending on the inpatient's values for each of the indicator's variables. The sum of the inpatient's coefficients gives this inpatient's contribution to the expected rate for a particular indicator for the hospital at which this inpatient was treated. The sum of all the hospital's inpatients' contributions is the hospital's expected rate. In this way, the expected rate shows the expected rate for other similar inpatients nationwide, providing a national comparison for each Utah hospital and Utah overall.

For Congestive Heart Failure Death (IQI 16), the logistic regression equation is
$$M = I + C1 + C2 + C3 + C4$$
where

M = inpatient's contribution to the expected rate
I = intercept = -5.304
$C1$ = age coefficient
$C2$ = sex coefficient
$C3$ = age sex interaction coefficient
$C4$ = APR-DRG risk of mortality interaction coefficient

For example, among all congestive heart failure patients that IQI 16 includes in its denominator, a congestive heart failure male inpatient, age 62, with a minor level of risk of mortality contributes to his hospital's expected rate

$$-5.305 = -5.304 + 0.000 + 0.000 + 0.000 + 0.000$$

and a congestive heart failure female inpatient, age 87, with a moderate level of risk of mortality contributes to her hospital's expected rate

$$-3.621 = -5.304 + 0.663 + (-0.066) + (-0.023) + 1.109$$

etc. for all other congestive heart failure patients. The M values for all IQI 16 congestive heart failure inpatients are combined using the following formula to give the hospital's expected death rate for congestive heart failure.

$$ER = sum(Exp(M) / (1.000 + Exp(M)) / P)$$
where

ER=expected death rate
Exp is the exponent function, in this case, e raised to the power of M
M = inpatient's contribution to the expected rate
P = number of patients this indicator includes for this hospital.

The expected death rate for Utah overall is the above formula for all of Utah inpatients selected for this AHRQ congestive heart failure indicator.